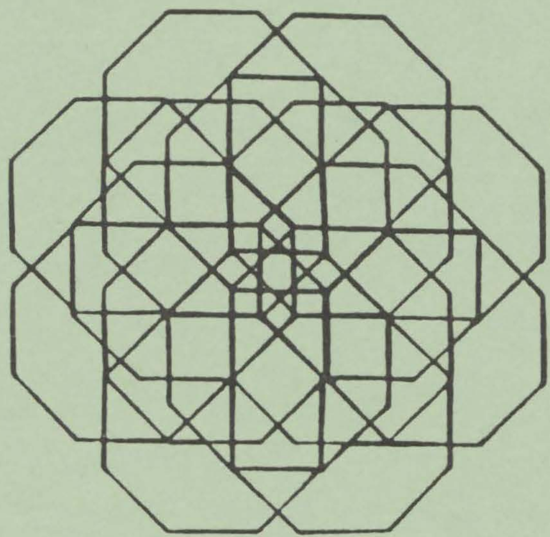
Environment and the River: Maps of the Mississippi



by William J. Craig
and William S. Anderson

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Report to
The McKnight Foundation

Mississippi River
Environmental Data Inventory Project

October 1991
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1991

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PREFACE

In late 1990, the Minneapolis-based McKnight Foundation decided to create an environmental grantmaking program. Grantmaking will rise to five million dollars annually when the program is fully developed. It was decided early-on to use the Mississippi River as the focus of their concerns and activity. Thomas Anding, associate director of CURA, had promoted the idea of the Mississippi River as the environmental barometer for the core of the nation. In the middle two-fifths of the country, anything that fouls the environment inside the Mississippi's basin is proclaimed by changes in the river. The foundation's goal is to develop a program aimed at ensuring that "...a healthy, sustainable environment is maintained and, where necessary, restored in the Mississippi basin."

In January, 1991 the McKnight Foundation made a grant to the Center for Urban and Regional Affairs to produce a reconnaissance of baseline environmental data on the Mississippi River. This report is a product of that effort. It focuses on geographic data about the environment of the Mississippi River. Based on the work of collecting and analyzing these data we make recommendations about how the McKnight Foundation might best affect the environmental quality of the Mississippi River basin. Earlier efforts resulted in reports that produced inventories of: 1) the published literature about the Mississippi and its environment and 2) comprehensive river planning documents from the United States and Canada. These inventories were printed in very limited quantities and are available for reading or copying (for a fee) at both the McKnight and CURA offices.

The nature and format of this report have been heavily influenced by the new environmental program officer at the McKnight Foundation, Daniel Ray. The maps that follow are divided into three sections: the status of the river itself, insults to the river from human activity in the basin, and the capacity of people in the basin to cope with environmental problems. These categories help one understand the environment of the river and its basin. They will also help the McKnight Foundation develop its grantmaking program.

The Foundation sponsored this report, but has agreed that CURA could publish and distribute it widely. We wish to thank the Cartography Laboratory of the Geography Department at the University of Minnesota, and especially Alan Willis, for producing the maps in this report. We hope that the report will be of interest and use to many people throughout the region.

William J. Craig
Center for Urban and Regional Affairs
October 1991

INTRODUCTION

Geographic information is presented in the following pages which illustrates the environment of the Mississippi River and its basin. Maps showing the environmental status of the river itself are shown in the first section. A second set of maps demonstrates insults to the river, looking at potentially harmful human activity within the basin. The last set of maps focuses on the capacity of individuals and society to cope with the environmental problems of the river.

These maps represent an innovative and instructive way to view the environment of the Mississippi River. The number of map themes that could have been presented is enormous. We have chosen themes that are both significant in themselves and representative of the types of environmental problems facing the river and its basin.

Data gathered for these maps are from a variety of sources. These dispersed databases illustrate the problems encountered when trying to understand the river and the need for centralized data retrieval and analysis. Our ability to comprehend the problems facing the river, much less propose solutions, is contingent upon reliable data. In all too many cases, such reliable data do not exist or are so scattered and inconsistent that they are not valuable in understanding the condition of the whole system.

A number of important maps are missing from this atlas. Maps which we were unable to produce include: plant diversity and loss of original vegetation, animal counts and diversity, dissolved oxygen in the river, industrial pollutants in the river, air quality, municipal sewer discharges, state-by-state public opinion, environmental laws, and diseases related to water. We were limited in the number and variety of maps we could produce by a number of factors. Factors included lack of data (no existing research), variable and/or unknown quality of data, limited observation sites and times, and an unwillingness to release data. As a consequence, we often used results from published studies, rather than working from raw data sets. The source for each map is described on the map itself.

By its nature, this is a macro-level study. Each map shows one environmental theme for a major portion of the United States on a single sheet of paper. Some details are necessarily eliminated in the process of producing an overview of the trends and variations along the river or across the basin.

PART 1. STATUS OF THE RIVER

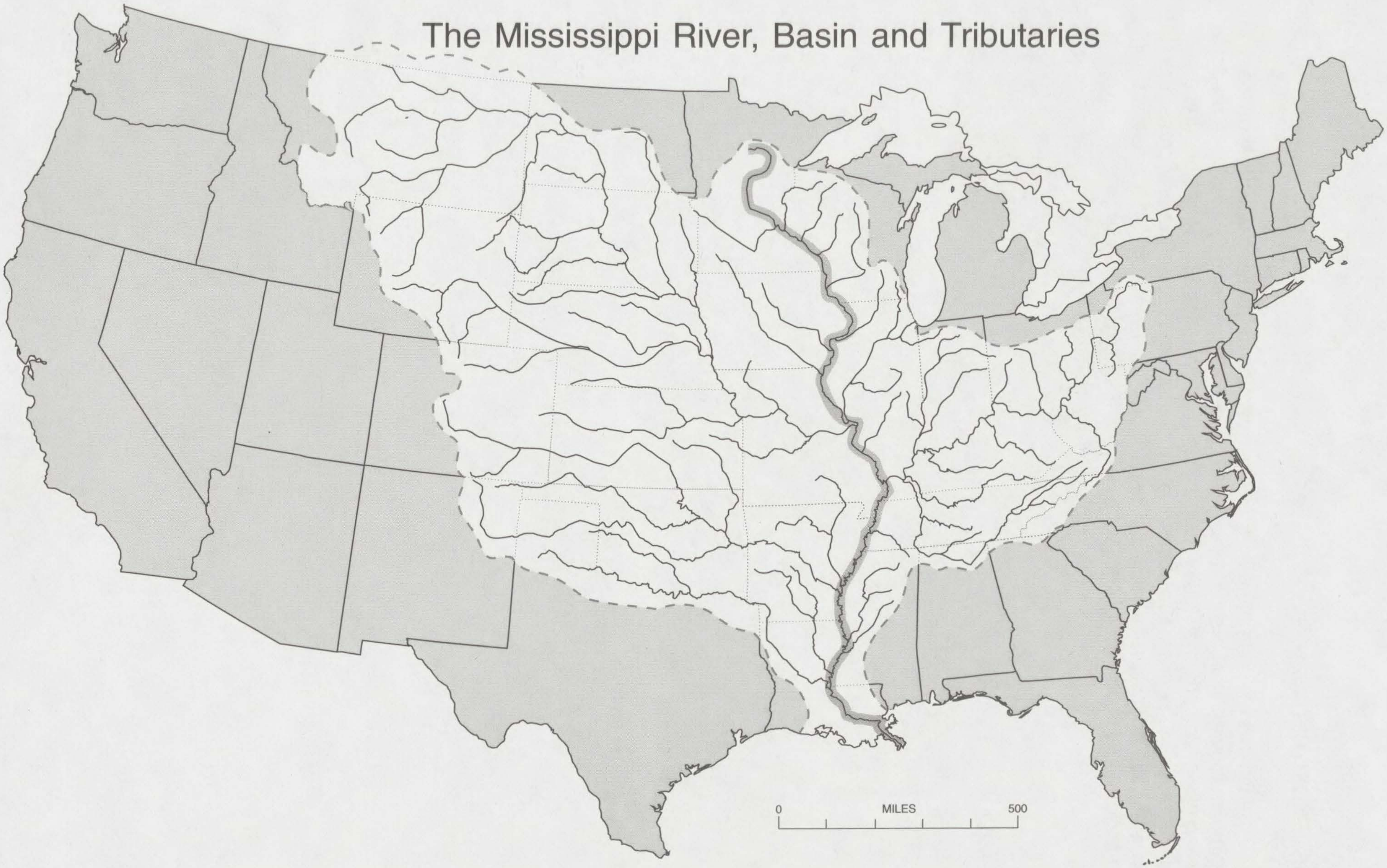
The maps in this section show the extent of the Mississippi system and the current environmental status of the river and its adjacent lands. The last map in the series, recreation sites, shows the human reaction to the current status of the river.

Maps in this series represent the varying quality of the river environment by varying the width of a schematic band following the river. The wider the band, the bigger the environmental problem. Each of these maps is labeled to show the location and readings of data collection stations. We have interpolated the data between these points to show a smooth increase or decrease, simply because of the limited number of sampling stations. We do not have enough data to know exactly where significant changes occur.

In general, problems get worse as one travels down-river, but dilution by cleaner tributaries can produce an apparent lessening of the problem. In fact, the situation is worse than it may appear, because all problems are measured here in quantity per unit of water volume. The total volume of the river is always increasing as it flows downstream, while the total quantity of fertilizer (or other substance) is also increasing at a rate much faster than what is shown on these maps.

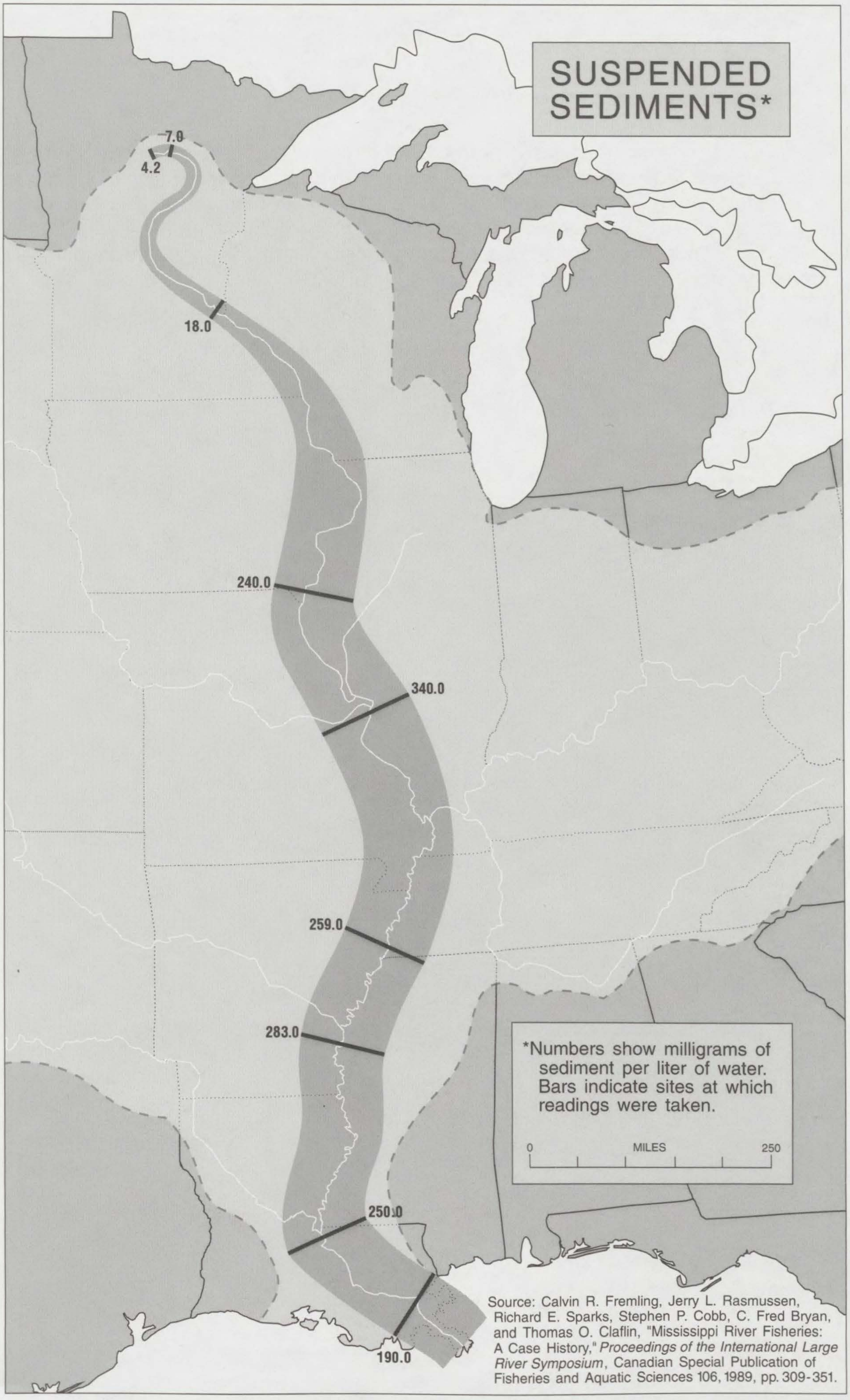
BASEMAP

The Mississippi River runs 2,358 miles from its origin at Lake Itasca, Minnesota, to the Gulf of Mexico. With its tributaries, the Mississippi drains 1,231,000 square miles—an area that covers all or parts of thirty-three states and two Canadian provinces. It is the dominant watershed of the North American continent and second largest drainage basin in the world.


The Mississippi River, Basin and Tributaries
0
MILES
500

SUSPENDED SEDIMENTS

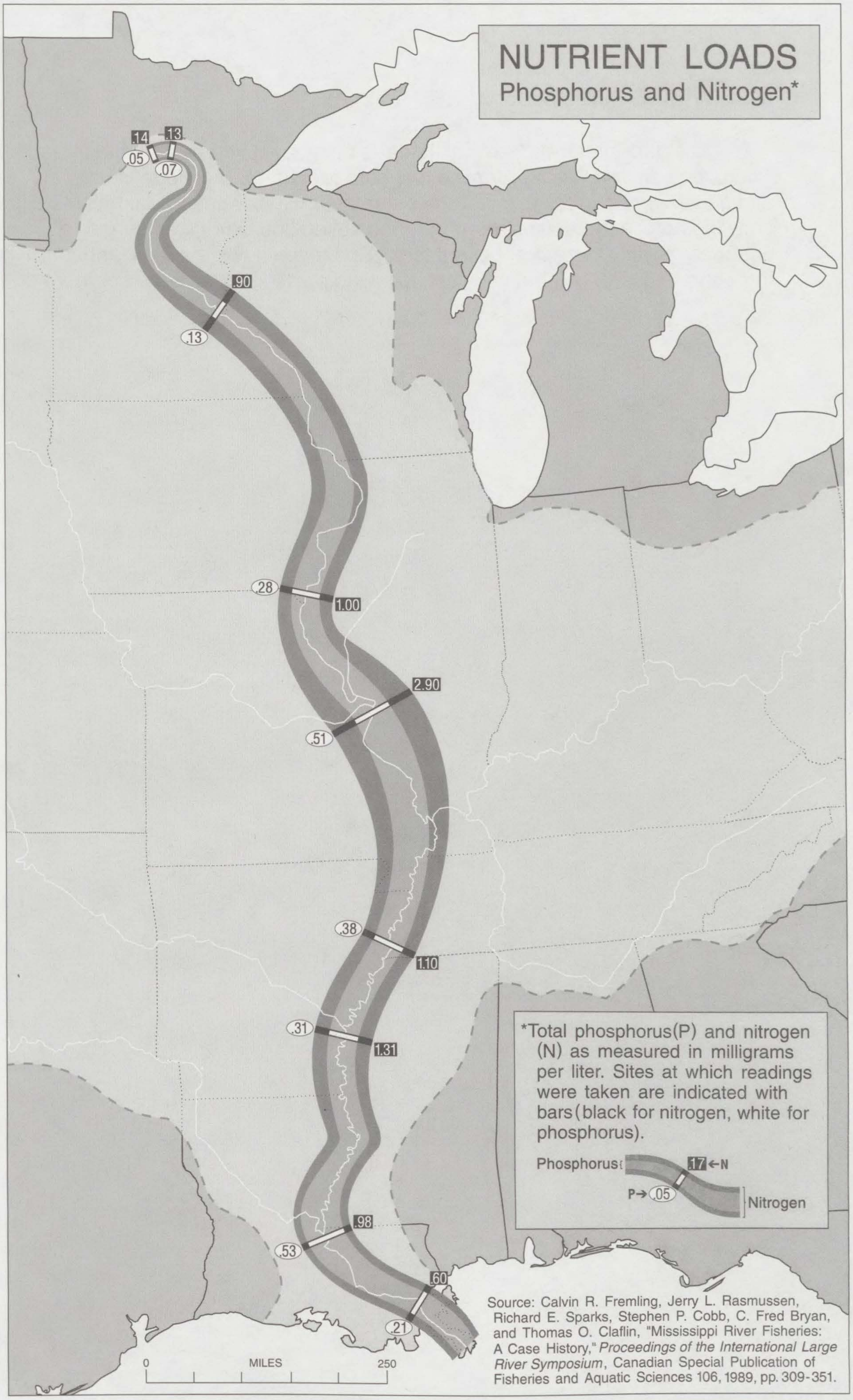
Sediments are a problem both for the river and for the land which feeds the river. Sedimentation can fill pools and backwaters and lead to a need for extensive dredging to keep navigation channels open. Soil erosion from farmland is the major source of sedimentation in the river. The concentration of sediments in the water increases throughout the agricultural parts of the region, then holds steady or decreases as sediments drop out and the river is diluted by tributaries carrying less sediment.



SUSPENDED SEDIMENTS*
7.0
4.2
18.0
240.0
340.0
259.0
283.0
250.0
190.0
*Numbers show milligrams of sediment per liter of water. Bars indicate sites at which readings were taken.
0
MILES
250
Source: Calvin R. Fremling, Jerry L. Rasmussen, Richard E. Sparks, Stephen P. Cobb, C. Fred Bryan, and Thomas O. Claflin, "Mississippi River Fisheries: A Case History," *Proceedings of the International Large River Symposium*, Canadian Special Publication of Fisheries and Aquatic Sciences 106, 1989, pp. 309-351.

NUTRIENT LOADS

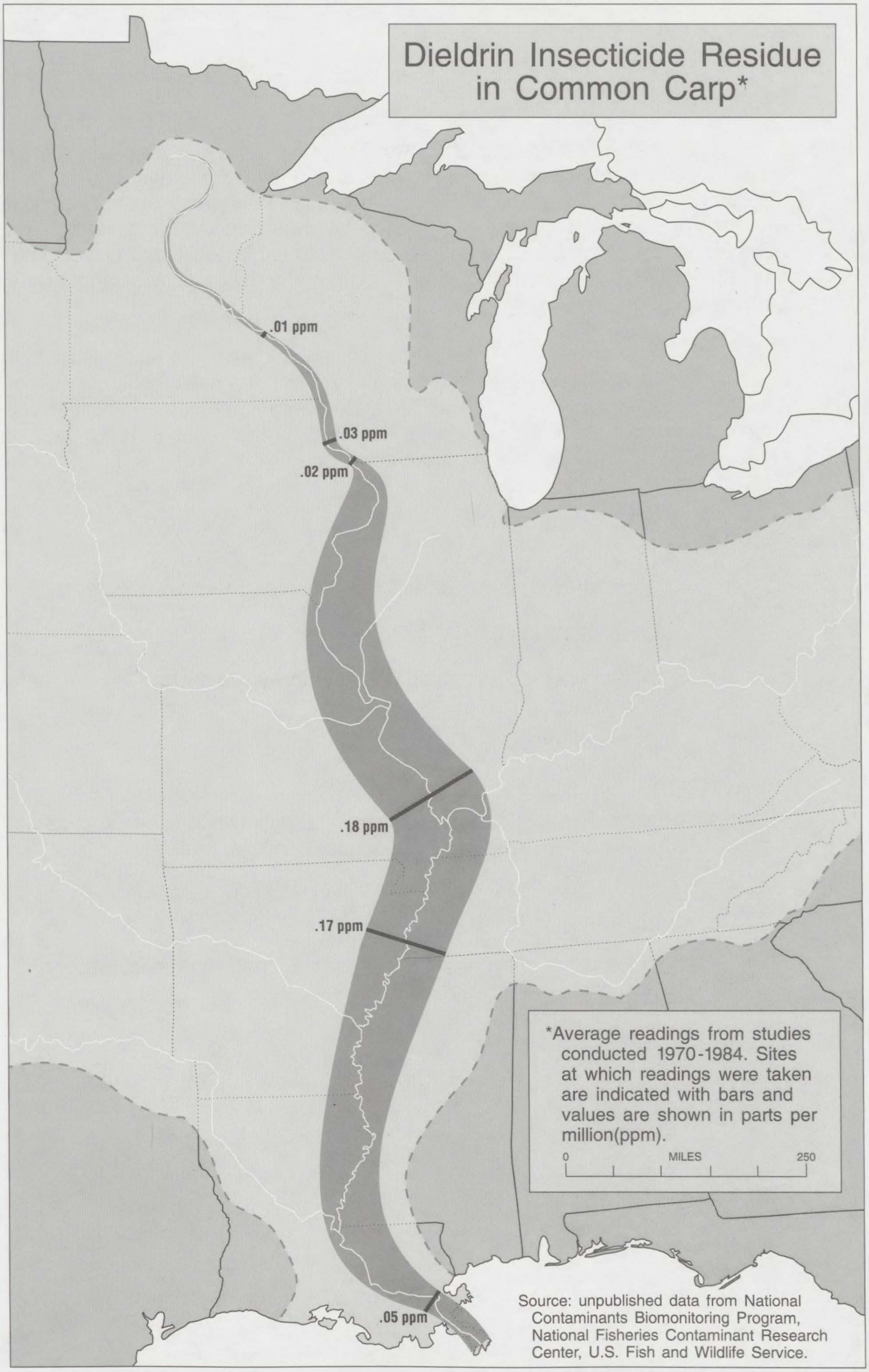
This one map shows both phosphorus and nitrogen, major ingredients in cropland fertilizer and urban wastewater. The phosphorus band is superimposed on top of the nitrogen band. In general, twice as much nitrogen is used on the land as phosphorus, and these relative proportions hold in the nutrient loads present in the Mississippi. Nitrogen and phosphorus concentrations increase throughout the agricultural Midwest, then decrease below St. Louis.



NUTRIENT LOADS
Phosphorus and Nitrogen*
.14
.13
.05
.07
.90
.13
.28
1.00
2.90
.51
.38
1.10
.31
1.31
.98
.53
.60
.21
*Total phosphorus(P) and nitrogen (N) as measured in milligrams per liter. Sites at which readings were taken are indicated with bars (black for nitrogen, white for phosphorus).
Phosphorus
.17 ←N
P→ .05
Nitrogen
0
MILES
250
Source: Calvin R. Fremling, Jerry L. Rasmussen, Richard E. Sparks, Stephen P. Cobb, C. Fred Bryan, and Thomas O. Claflin, "Mississippi River Fisheries: A Case History," *Proceedings of the International Large River Symposium*, Canadian Special Publication of Fisheries and Aquatic Sciences 106, 1989, pp. 309-351.

INSECTICIDE RESIDUE IN CARP

Dieldrin is a farm chemical that has been identified as a health threat to humans. The U.S. Fish and Wildlife Service has data for chemical residue in carp at six stations along the river. In order to cover the entire river we extended from these stations—showing no change downstream from the Luling Louisiana station and reducing the upstream portion to zero at Lake Itasca. This map shows the familiar pattern increases throughout the agricultural midwest, followed by decreases in the southern portion.


Dieldrin Insecticide Residue in Common Carp*
.01 ppm
.03 ppm
.02 ppm
.18 ppm
.17 ppm
.05 ppm
*Average readings from studies conducted 1970-1984. Sites at which readings were taken are indicated with bars and values are shown in parts per million(ppm).
0
MILES
250
Source: unpublished data from National Contaminants Biomonitoring Program, National Fisheries Contaminant Research Center, U.S. Fish and Wildlife Service.

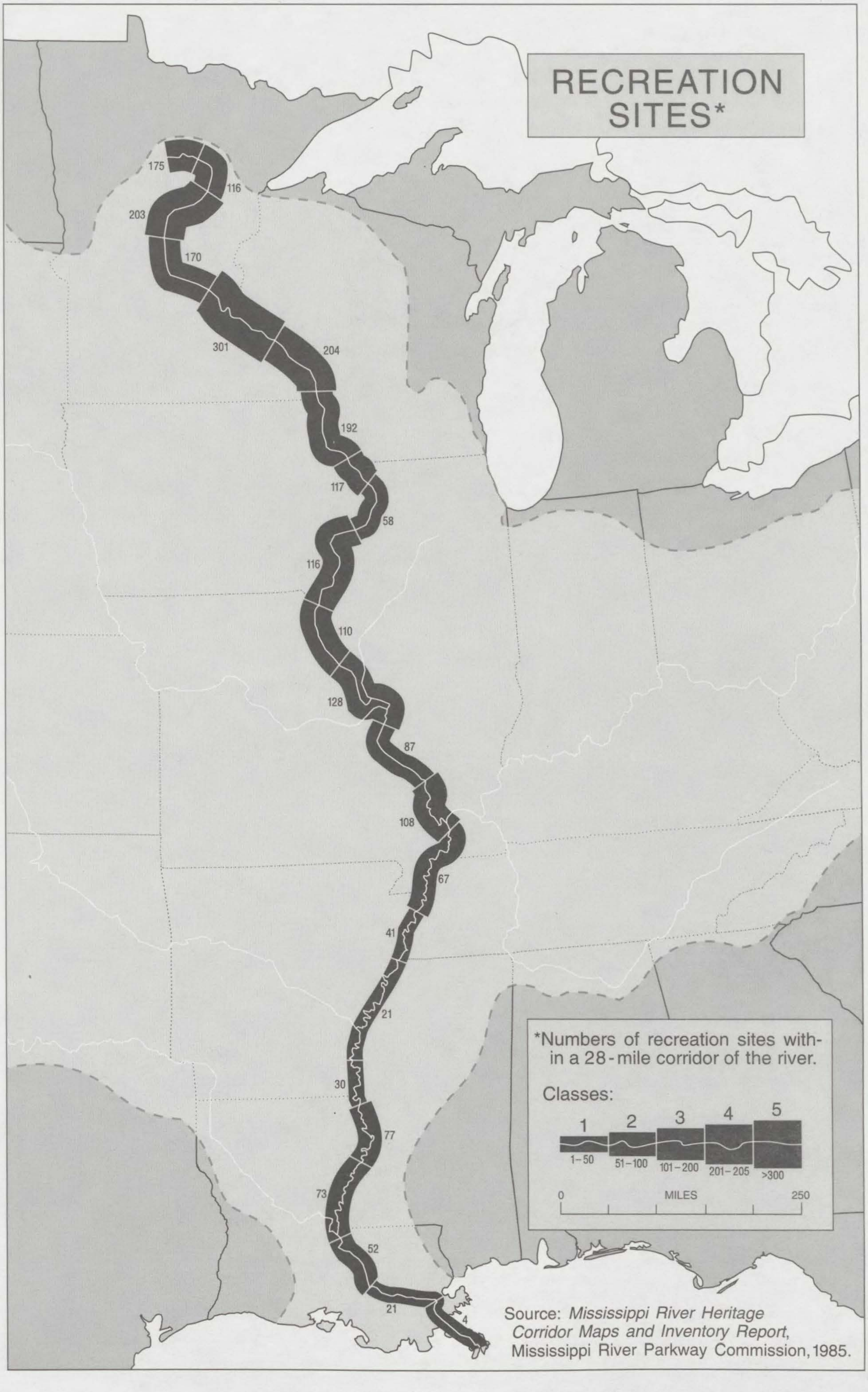
RECREATION SITES

The number of recreation sites along the river is a measure of environmental quality and local perception both of the river and of its nearby environment. The width of the band on this map is an indication of the number of recreation sites within each of twenty-three segments of the river; the map legend shows the band-width classes. The number by each segment is the actual count of sites. Minnesota is blessed with the most recreation sites. Clearly the southern end of the river has less to offer than the northern end.

The Mississippi River Parkway Commission did an inventory of recreation sites within a twenty-eight-mile wide band of the river (fourteen miles on either side of the river) from Lake Itasca to the Gulf. The inventory was presented on twenty-three map sheets using the eight broad categories listed below. Each map covered one segment of the river. The map opposite was created by counting the number of recreation sites on each map, as best we could (in some areas, many symbols overlapped).

Types of Recreation Sites Counted Along the River Corridor

- World heritage sites
- Federal areas—e.g., national forests and wildlife refuges, monuments, parks, historical parks, trails, cemeteries
- Natural landmarks
- Locks and dams
- State areas—e.g., state parks, natural areas, historic sites, recreation areas, fish and wildlife areas, trails, boat access areas, forests
- Sites on the National Register of Historic Places
- Natural areas
- Other locations of significance—e.g., industrial landmarks, museums, major public places and facilities, river ferries


RECREATION SITES*
175
116
203
170
301
204
192
117
58
116
110
128
87
108
67
41
21
30
77
73
52
21
4
*Numbers of recreation sites within a 28-mile corridor of the river.
Classes:
1
2
3
4
5
1-50
51-100
101-200
201-205
>300
0
MILES
250
Source: Mississippi River Heritage Corridor Maps and Inventory Report, Mississippi River Parkway Commission, 1985.

PART 2. INSULTS TO THE RIVER

People damage the river directly by discharging environmentally harmful material into the river and indirectly by their treatment of the land within the basin. Misuse of land in the basin will invariably affect the quality of the river itself through runoff. Insults come from agriculture, industry, the transportation system, and municipal sewage treatment plants.

The majority of the maps in this section show human activity in the states comprising the river basin. Eroded soils, flushed-out agricultural chemicals, and released industrial toxins wreak havoc on the land where they occur; much ends up in the Mississippi River because the land's holding capacity has been reduced by extensive drainage of wetlands. Twenty-one states are either predominantly or entirely within the basin.

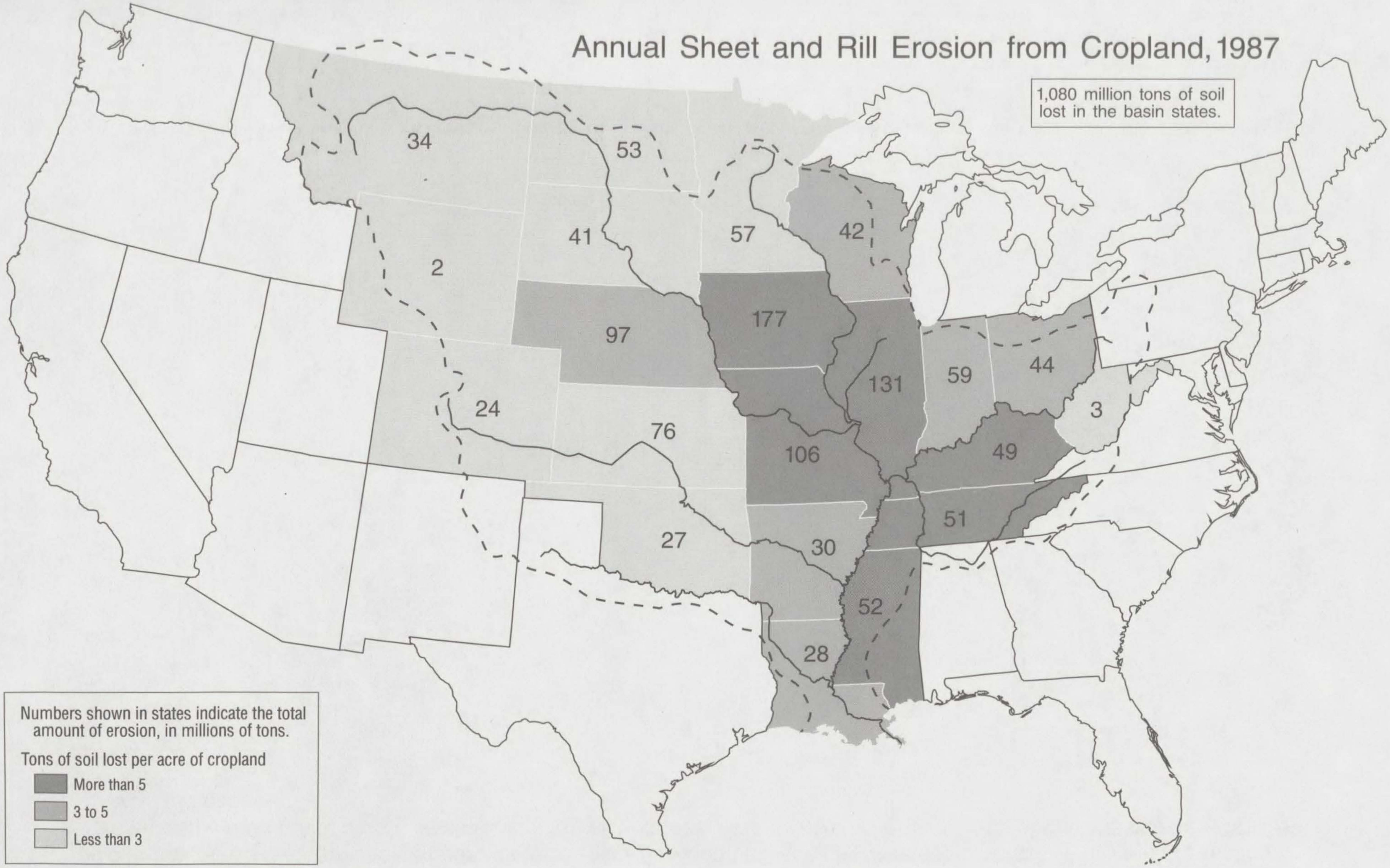
Maps in this section display data for those twenty-one states, with a dashed line showing the outside edge of the basin. Each of the first five maps shows two characteristics of any state: 1) the total amount of material added or removed and 2) the rate of application or loss. The total amount is shown as a number within the state while the rate is shown by the shading of the state. An example may help. The first map in this section shows annual sheet and rill erosion from cropland. Minnesota lost fifty-seven million tons of soil in 1987, but averaged losses of less than three tons per acre of cropland.

The last map in this section is about the average annual number of spills into the Mississippi River. For this map we are interested only in the ten states that abut the river. The two characteristics on this map are different from the others in this section: 1) the number of spills and 2) the number of major spills.

SOIL EROSION

Erosion can occur on many types of land use, but is most significant on cropland. The erosion shown on this map is caused by water, but significant additional losses can come from wind erosion. Approximately 1,080 million tons of soil were washed off cropland in 1987. The most severe losses were in the corn growing region of the basin. Losses of more than five tons per acre are considered intolerable—greater than what can be replaced by soil building activities. Six of the twenty-one basin states are above the five ton threshold, but individual counties in the other states are also above that threshold.

Annual Sheet and Rill Erosion from Cropland, 1987



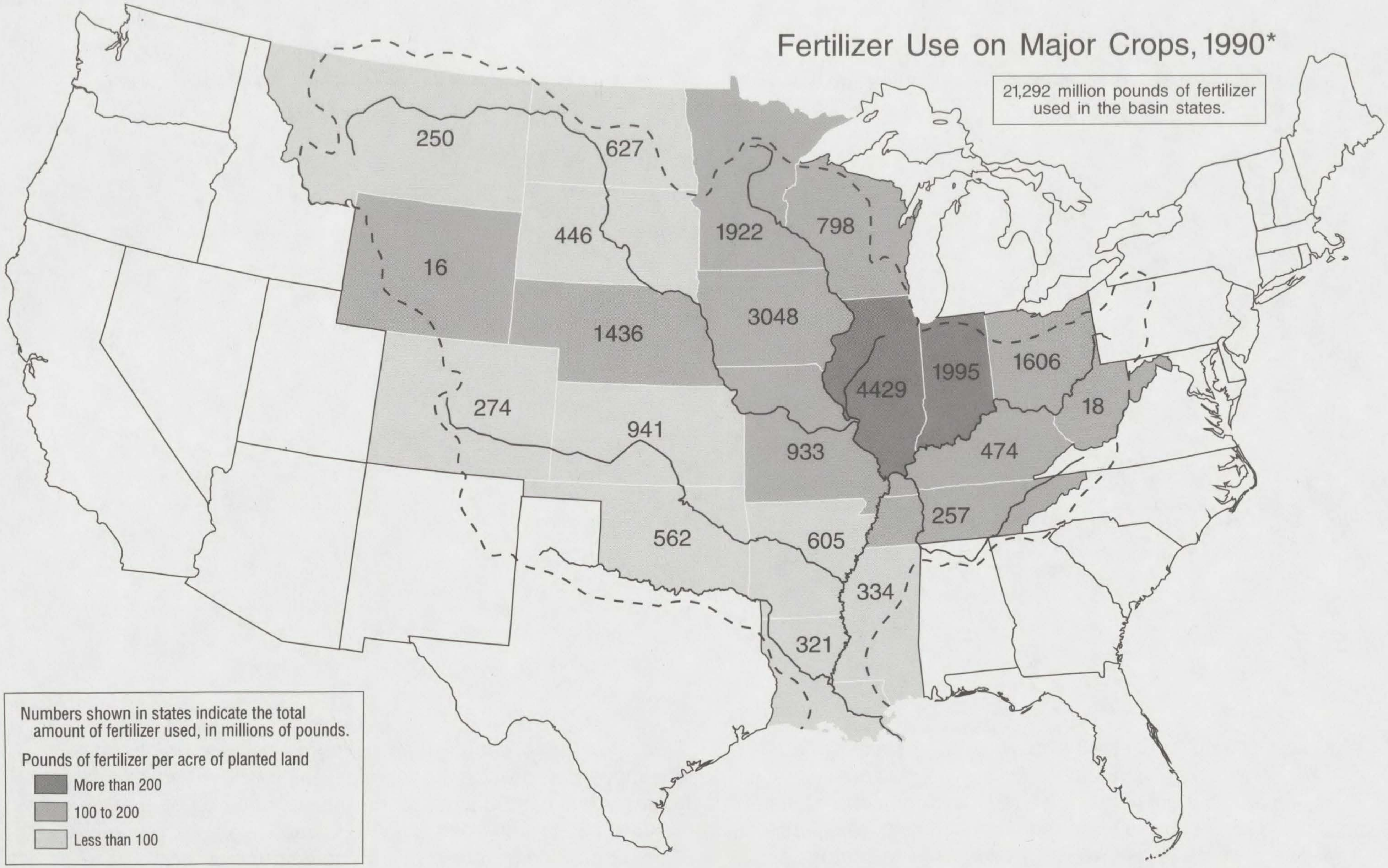
Source: *Summary Report: 1987 National Resources Inventory*, Soil Conservation Service, U.S. Department of Agriculture, Iowa State University Statistical Laboratory, Statistical Bulletin Number 790.

FERTILIZER USE

Over twenty-one billion pounds of chemical fertilizer were used in 1990. With luck and good management most of this went into the crop, but sudden storms and over-application too often result in these chemicals washing away. Roughly one-half of this fertilizer was nitrogen, the rest equally divided between phosphate and potash. While the application rate among the six major crops[1] was greatest for fall potatoes, corn received over two-thirds of the total chemical fertilizer used in the basin.

[1] While this report speaks of six major crops, the source document listed eight. For our purposes winter wheat, spring wheat, and durum wheat were combined into one group.

Fertilizer Use on Major Crops, 1990*



Source: *Agricultural Chemical Usage: 1990 Field Crops Summary*, U.S. Department of Agriculture, Ag Ch 1 (91), March 1991.

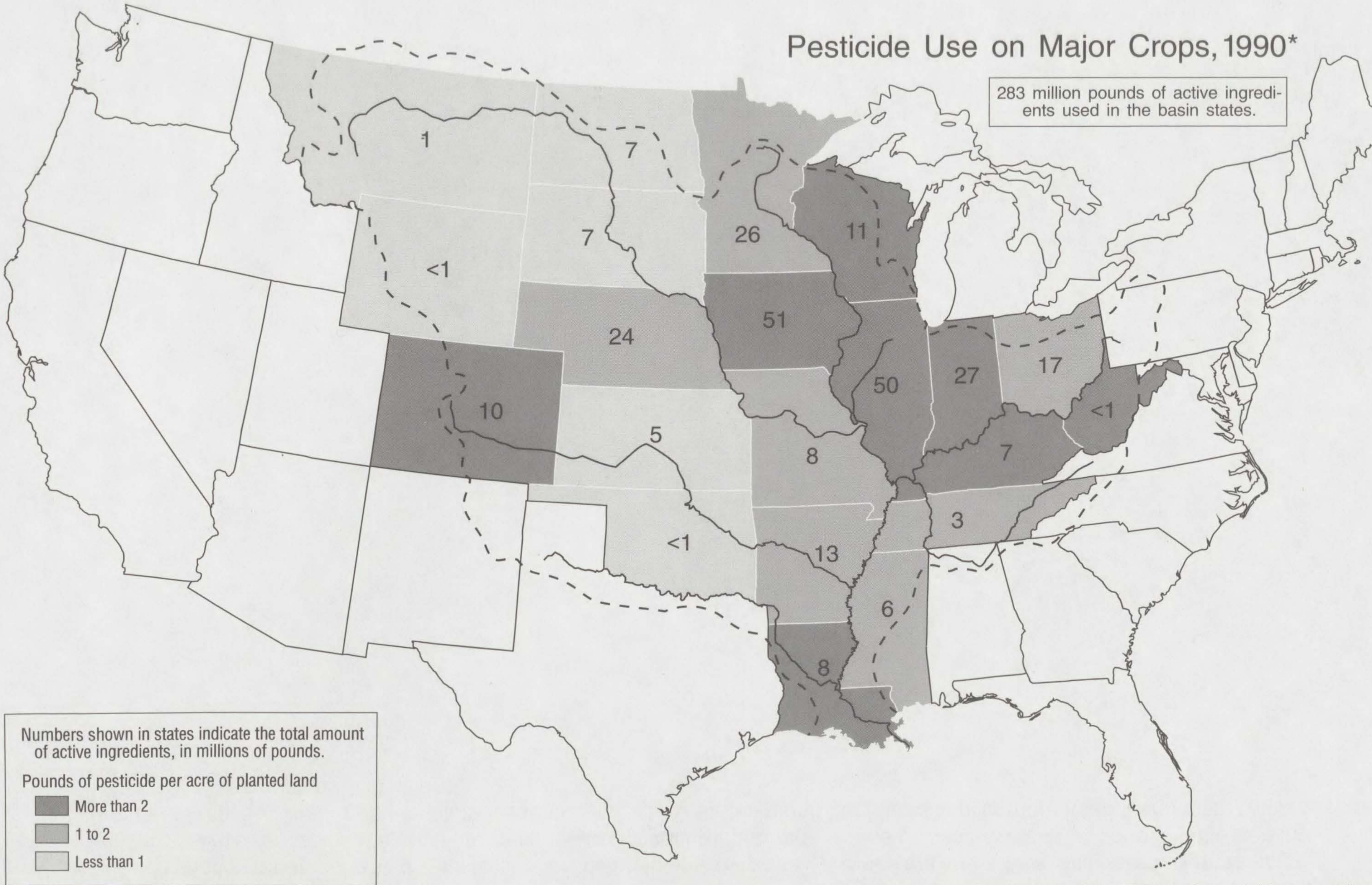
*Fertilizers include nitrogen, phosphate, and potash. Six major crops include: corn, soybeans, wheat, upland cotton, fall potatoes, and rice.

PESTICIDE USE

Over 283 million pounds of chemical pesticides were put on major crops in 1990. Additional pounds of some chemicals were applied in quantities too small to be reported at the state level[1] by the U.S. Department of Agriculture. Invariably, some pesticides intended to protect crops from weeds, insects, and fungi are washed away. In the river basin two-thirds of these chemicals are used on corn. Discounting the use of sulfuric acid on Colorado potatoes, the crop getting the greatest rate of application is rice—5.6 pounds per planted acre; Arkansas and Louisiana are the rice growing states.

[1] National totals are significantly larger than the sum of the state levels used for this map. Without state level data it was impossible to estimate basin totals.

Pesticide Use on Major Crops, 1990*



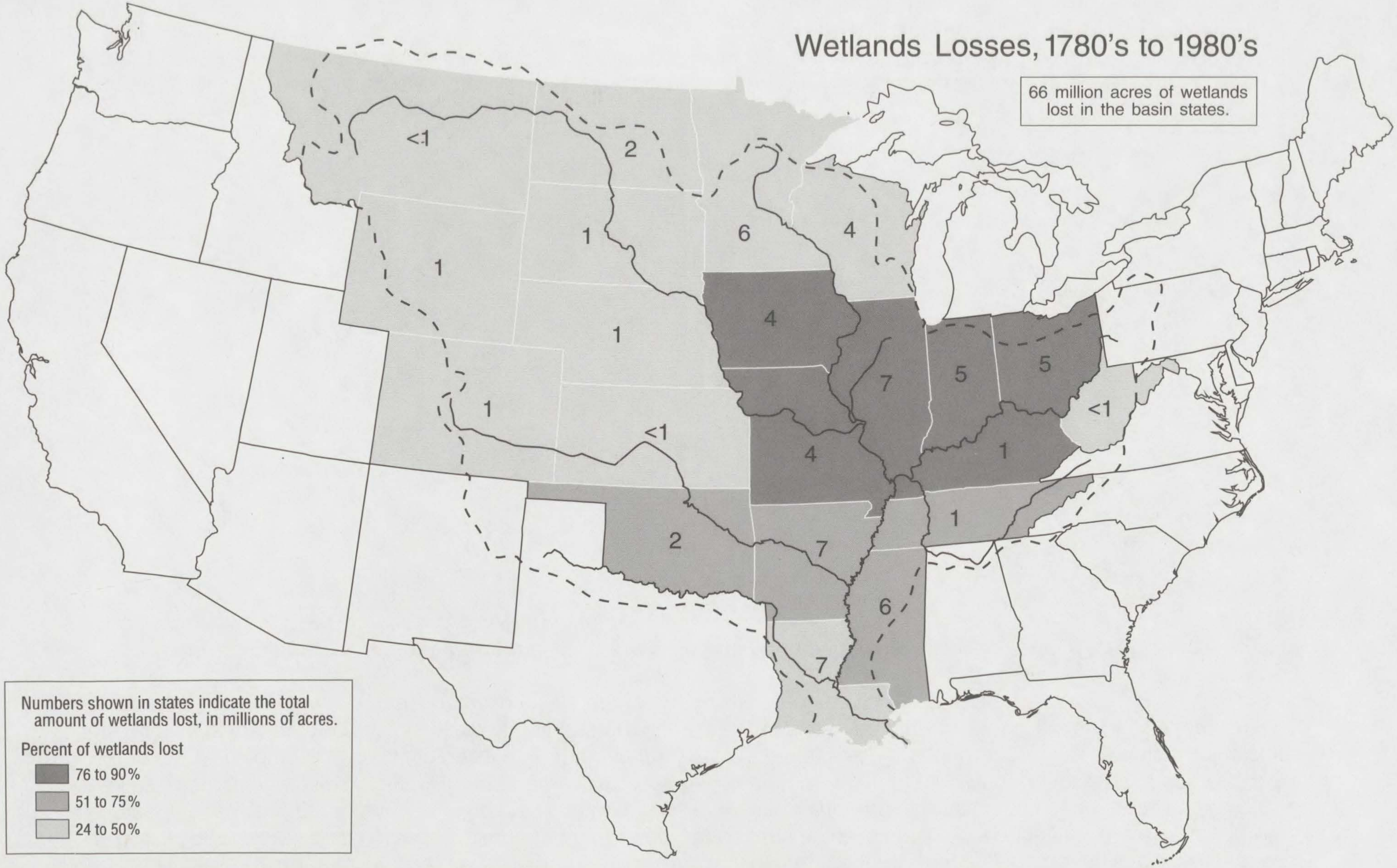
Source: *Agricultural Chemical Usage: 1990 Field Crops Summary*, U.S. Department of Agriculture, Ag Ch 1 (91), March 1991.

*Pesticides include dozens of herbicides, insecticides, and fungicides listed in the source document. Six major crops include: corn, soybeans, wheat, upland cotton, fall potatoes, and rice.

WETLANDS LOSSES

Wetlands are important to wildlife and for maintaining water quality. Since the late 1700s, sixty-six million acres of wetlands have been lost in the basin, largely due to agricultural drainage. Rates of loss have been greatest in the agricultural heartland, but the largest absolute losses have been in states along the Mississippi corridor itself: Minnesota, Illinois, Arkansas, Mississippi, and Louisiana.

Wetlands Losses, 1780's to 1980's



Source: Dahl, Thomas E., *Wetlands Losses in the United States, 1780's to 1980's*, U.S. Fish and Wildlife Service, 1990.

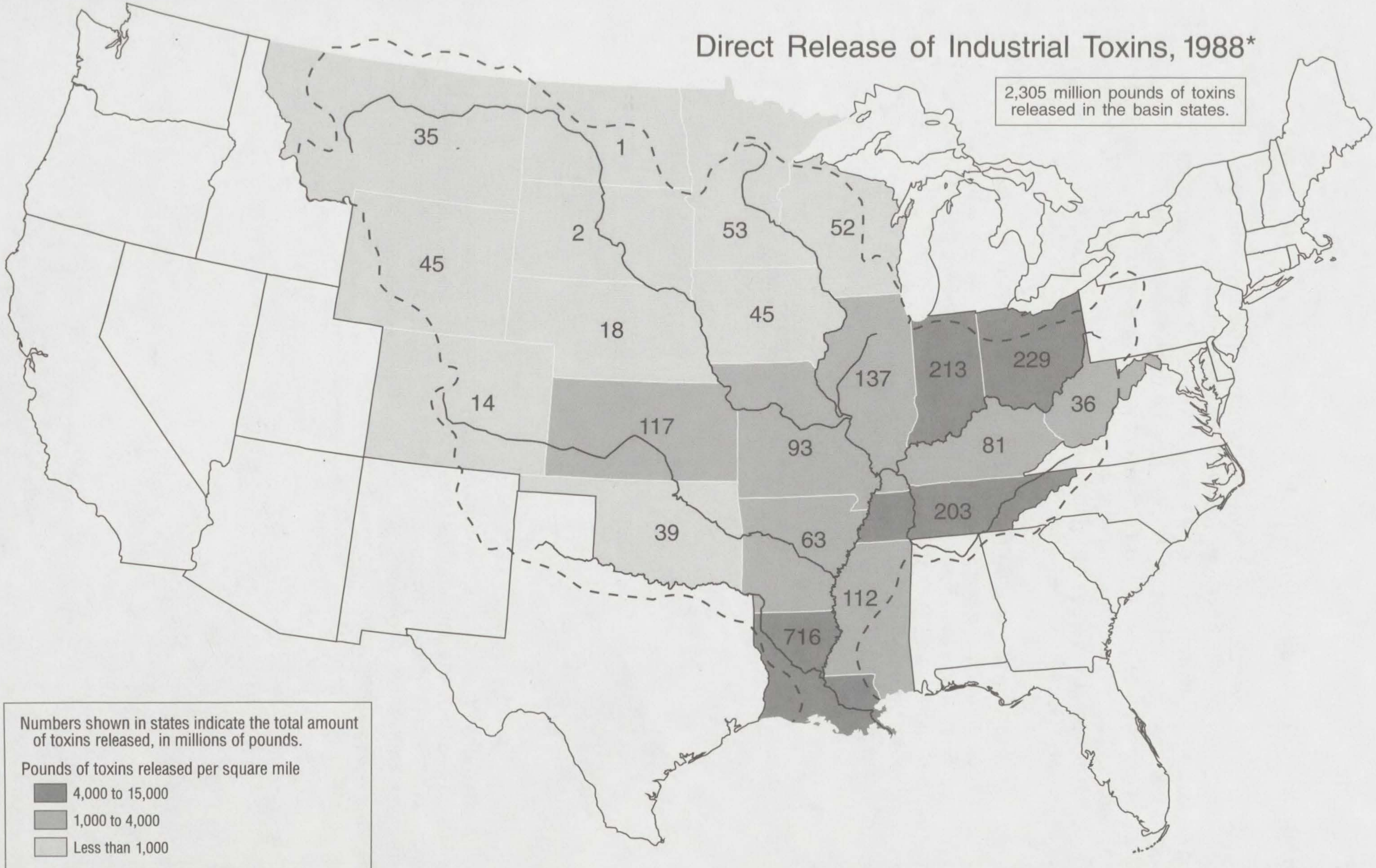
DIRECT RELEASE OF INDUSTRIAL TOXINS

At least 2.3 billion pounds of toxins were released into the environment by industries operating in the basin states in 1988. The federal Toxics Release Inventory (TRI) under-reports the actual situation because only two of every three companies required to report do so, and many companies are exempt. The rate of release has been dropping as companies adopt more pollution control measures and as they become more adept at reporting. Nationwide, 8 percent of the toxins are carcinogens. Across the basin (and the nation) the most releases are in Louisiana.[1] The chemical industry is the leading discharger across the basin. In the eastern Great Lakes states, the primary metal industry's releases are of comparable magnitude, but many of these toxins are released into the Great Lakes watershed.

Our map is based on state total data because that fits with our macro-level analyses. The TRI database is available for closer analysis at the county and company level.[2]

[1] Louisiana injects 59 percent of its releases into the ground, accounting for over half the underground releases of the basin.
[2] See *Toxics in the Community*, the source for this map.

Direct Release of Industrial Toxins, 1988*



Source: *Toxics in the Community: National and Local Perspectives*, U.S. Environmental Protection Agency, 1990, Tables 5-12.

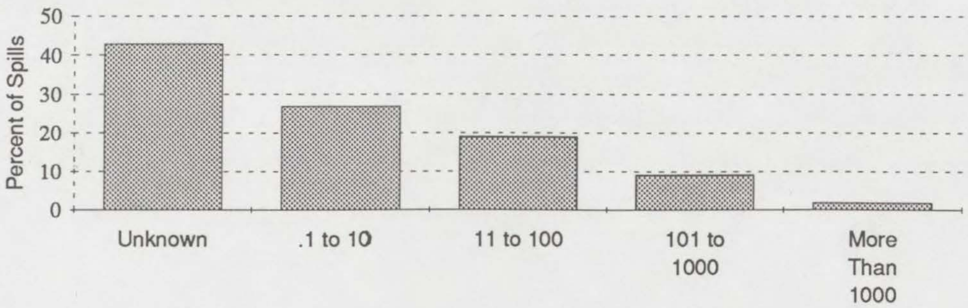
*47% air emissions, 9% surface water discharges, 10% land disposal, and 34% underground discharges. Another 781 million pounds were released into public sewers in the basin.

AVERAGE ANNUAL NUMBER OF SPILLS

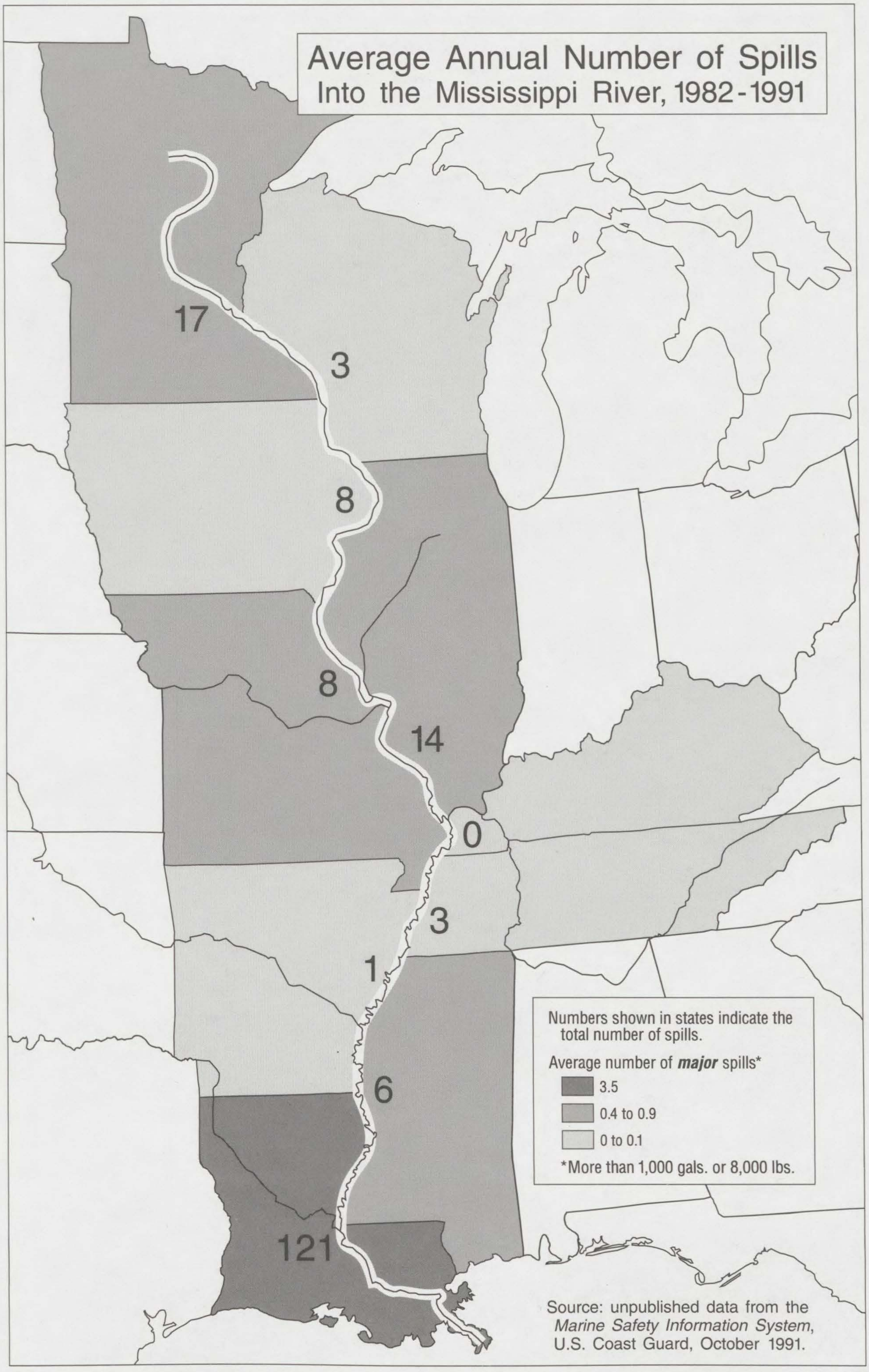
Spills into the river cause environmental damage. This map summarizes ten years of spills as reported to the Coast Guard. Most often these spills are oils and chemicals, but saltwater and wastewater are also included. Over the ten-year period, 1,810 spills occurred, an average of 181 per year. Louisiana was the location of most of the spills, averaging twice as many spills as the other nine states combined. Minnesota ranks a distant second. The number of reported spills has increased over time: from 1982-1986 there were an average of 116 per year, and from 1987 to 1991 an average of 246 per year. By October of 1991, there had already been 378 spills into the river.

Most spills are small. We graphed the size of spills for 1990, a typical recent year. Forty-three percent of the spills were of unknown size, usually a sign that they were quite minor—perhaps identified by the sighting of a slick. Only 2 percent of the spills were major, more than 1,000 gallons. The shading on the map indicates the average number of major spills into the river. Once again, Louisiana leads all states, averaging 3.5 major spills per year.

Gallons Per Spill, 1990



We attempted to determine the number of gallons spilled, but the original data did not lend themselves to such analysis. From 1987 to 1991, we calculated that 1.5 million gallons were spilled into the river, plus 1.6 million pounds. A rough attempt to combine these figures into a common measurement yields an estimated average of 336 thousand gallons per year spilled into the Mississippi River.



Average Annual Number of Spills
Into the Mississippi River, 1982-1991
17
3
8
8
14
0
3
1
6
121
Numbers shown in states indicate the total number of spills.
Average number of major spills*
3.5
0.4 to 0.9
0 to 0.1
*More than 1,000 gals. or 8,000 lbs.
Source: unpublished data from the Marine Safety Information System, U.S. Coast Guard, October 1991.

PART 3. COPING CAPACITY

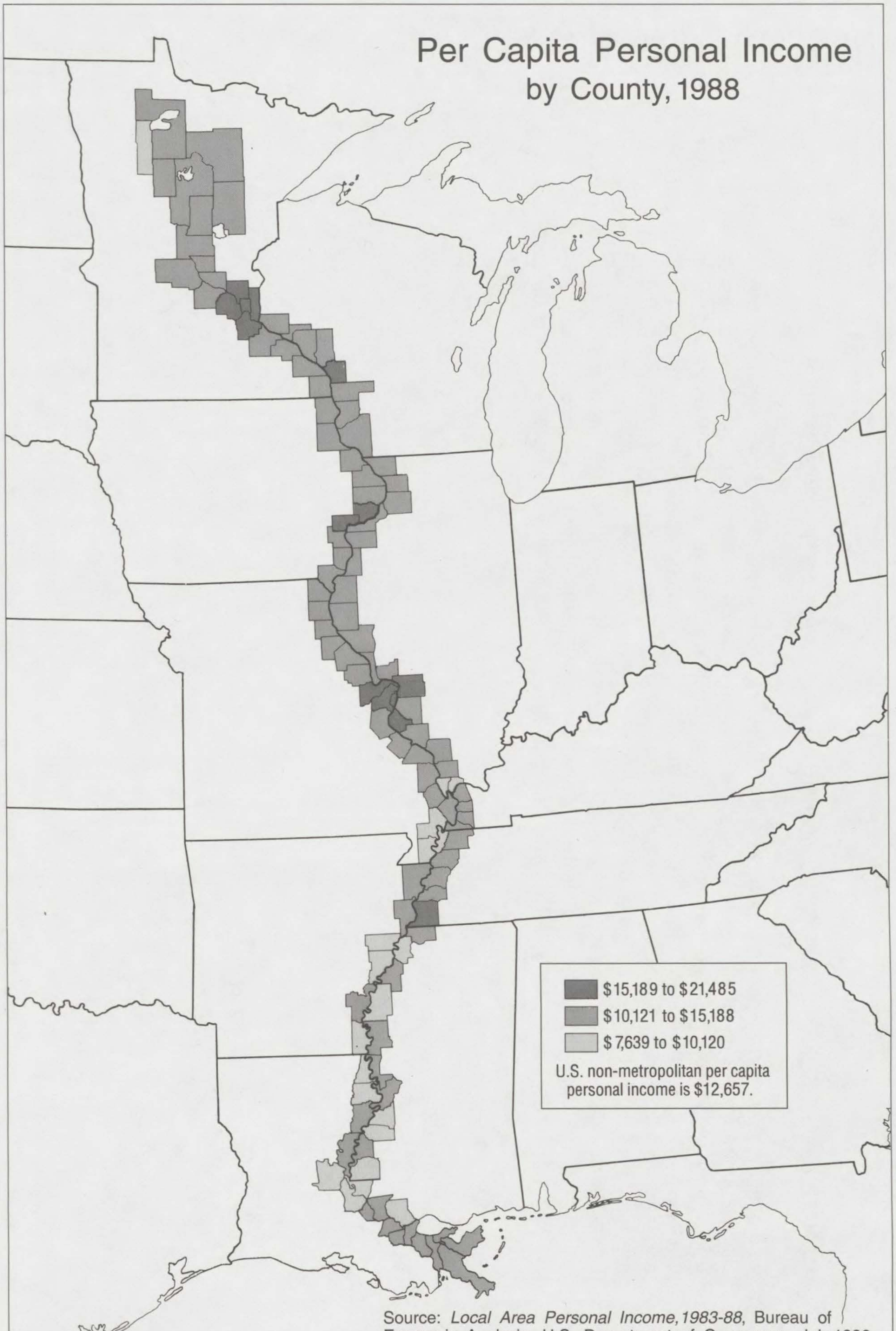
The capacity of individuals and society to deal with the environmental problems of the river is varied and limited. Too often the poorest people suffer the worst indignities. Our societal ability to rise to the environmental challenge varies with our ability to cooperate and coordinate across political, geographic, and topical areas. Often the best response comes, not from government, but from nonprofit environmental groups.

Other types of maps are used in this section. The income map shows three shaded patterns, but the unit of analysis is the county rather than the state. Income is displayed for the 118 counties adjacent to the river. The map of federal agency jurisdictions and interstate agreements is a schematic representation, intended to highlight the geographic fragmentation of responsibility. The map of nonprofit environmental groups is similar to the earlier maps, showing counts and rates for each of the twenty-one basin states.

PER CAPITA PERSONAL INCOME

Poorer people are less able to affect societal decisions and protect themselves. This map shows that the lowest levels of personal income are at the southern end of the river, especially below Memphis. Metropolitan areas have the highest income levels, but Louisiana is among the poorer states and its metropolitan counties do not rise above the middle income level.

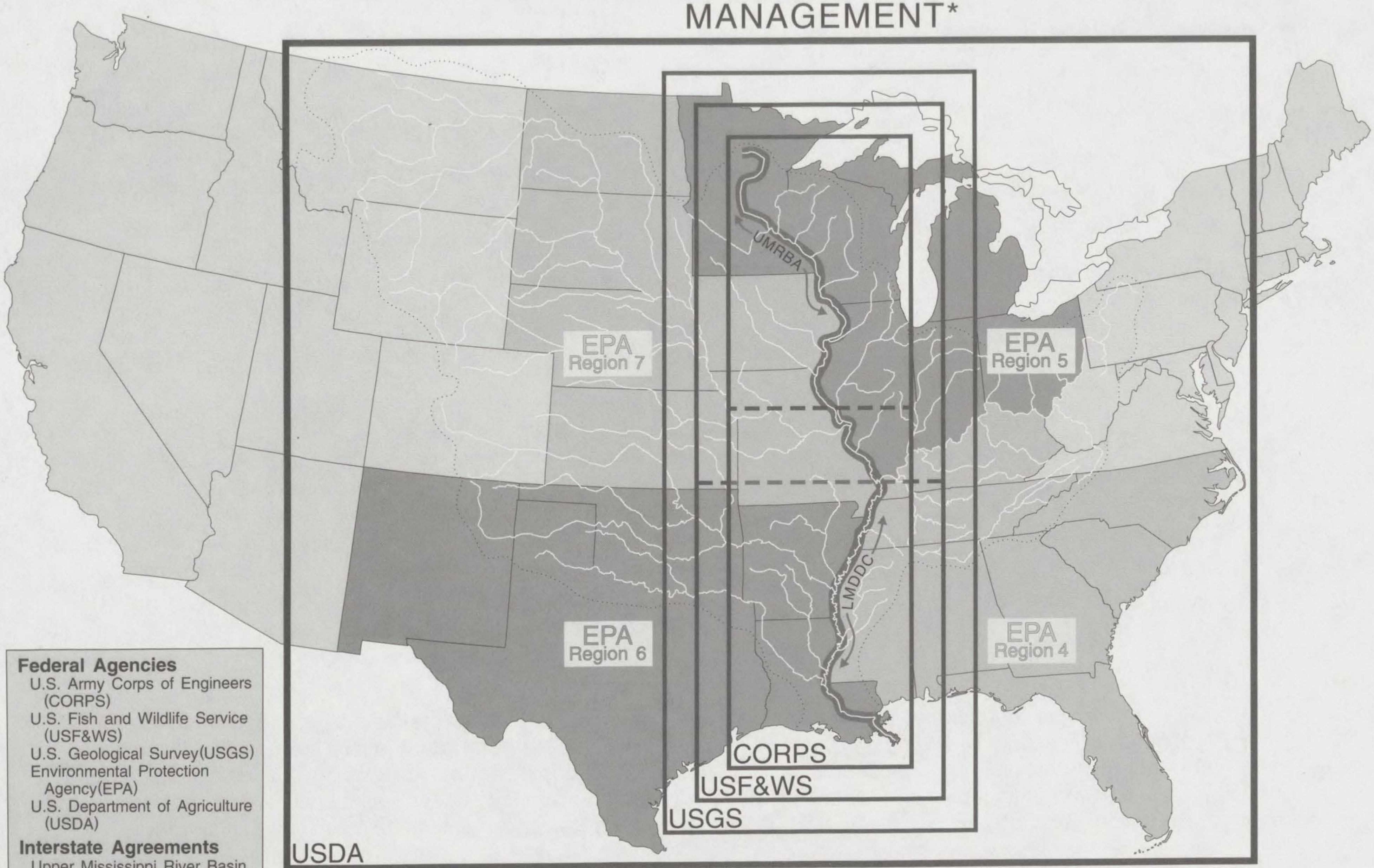
The categorical breakpoints shown on our map are tied to the national per capita income, which is $12,657 for nonmetropolitan areas. Our breakpoints are 20 percent above ($15,188) and 20 percent below ($10,126) the national figure. Counties in the lowest group are among the poorest in the country. No rural county appears in the highest group, only metropolitan counties.


Per Capita Personal Income
by County, 1988
$15,189 to $21,485
$10,121 to $15,188
$7,639 to $10,120
U.S. non-metropolitan per capita
personal income is $12,657.
Source: *Local Area Personal Income, 1983-88*, Bureau of
Economic Analysis, U.S. Department of Commerce, July 1990.

MANAGEMENT-FEDERAL AGENCY JURISDICTION AND INTERSTATE AGREEMENTS

One of the most serious problems for the Mississippi River is the fragmentation of environmental management responsibilities among government agencies. While a few agencies provide national management (e.g. the Department of Agriculture), others split management among regional offices in ways that put the river on the margin of individual responsibilities. The Environmental Protection Agency deals with the Mississippi River from four offices. The Corps of Engineers and the Fish and Wildlife Service each divide the river into two regions, and each has multiple districts within these regions. The Corps of Engineers divides the river at Lock and Dam Number 24. The Fish and Wildlife Service divides it at Cairo, Illinois. Interstate agreements are a useful way to overcome political fragmentation, but no agreement covers the entire river. The Upper Mississippi River Basin Association, for example, coordinates water resource planning among river states and between those states and the many federal agencies, but for only the five states north of Cairo, Illinois.

MANAGEMENT*



Federal Agencies
- U.S. Army Corps of Engineers (CORPS)
- U.S. Fish and Wildlife Service (USF&WS)
- U.S. Geological Survey(USGS)
- Environmental Protection Agency(EPA)
- U.S. Department of Agriculture (USDA)

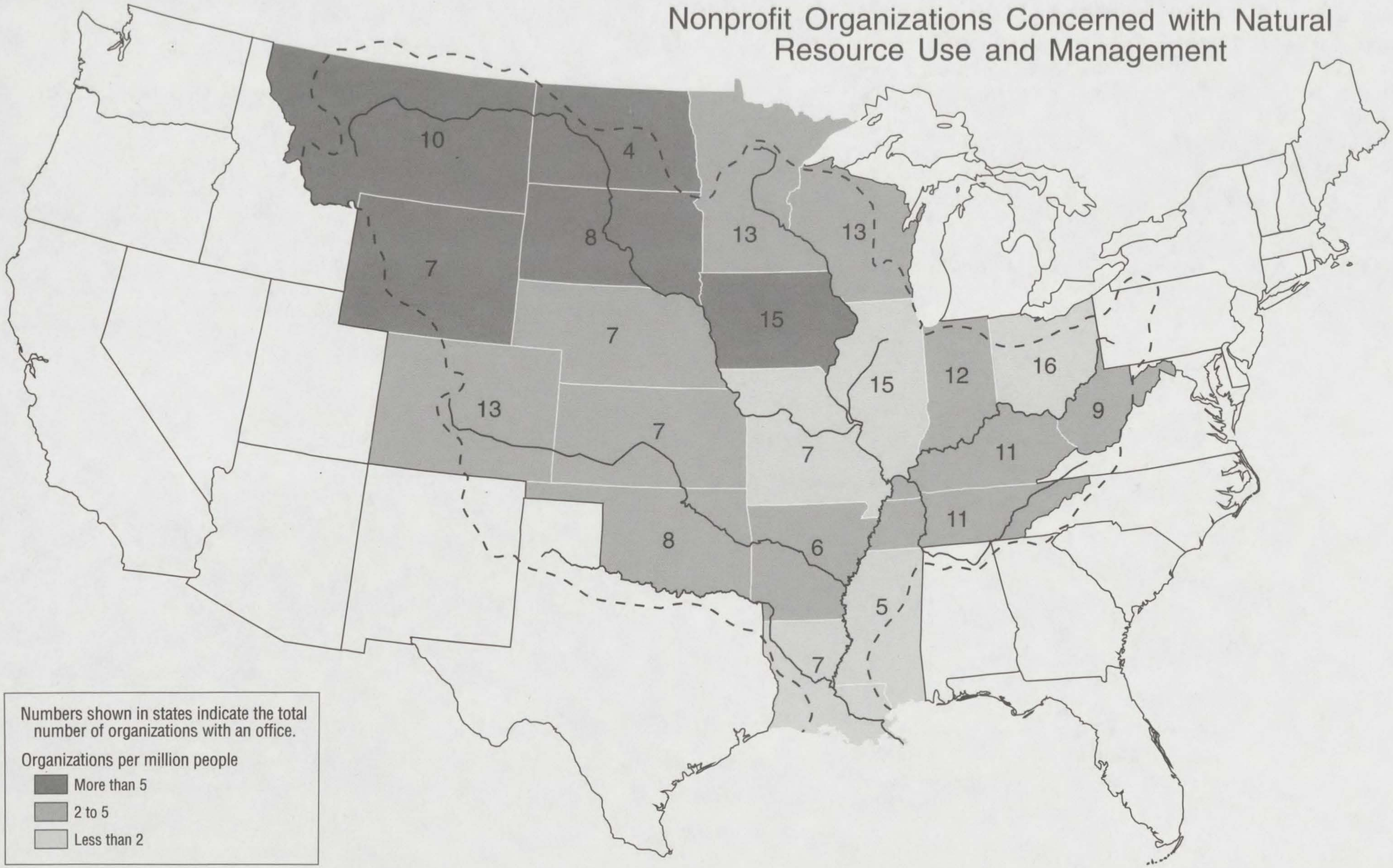
Interstate Agreements
- Upper Mississippi River Basin Association(UMRBA)
- Lower Mississippi Delta Development Center(LMDDC)

*This map differs from others in the report in that it is a schematic representation of the multiplicity of agencies with management authority for different aspects of the river. In addition, within the basin there are more than a dozen interstate compacts and agreements affecting the tributaries of the Mississippi.

NONPROFIT ENVIRONMENTAL ORGANIZATIONS

Nonprofit groups provide an alternative way for people to organize to make their will a reality. The number of such groups operating within any one state is a measure of the strength and diversity of environmental concern within that state. Every state has a significant number of such groups, none has fewer than four. The number of organizations per thousand people shows a different picture, with larger states (e.g. Illinois and Ohio) seeming to be undersupplied and more sparsely populated states (e.g., Iowa and Montana) looking like hotbeds of environmental activity.

Nonprofit Organizations Concerned with Natural Resource Use and Management



Source: *Conservation Directory*, National Wildlife Federation, 1991.

CONCLUSIONS AND RECOMMENDATIONS

Everyone seems to know about the Mississippi River and some care about it deeply. But too few people seem to know what to do to improve the river. At least there is no consensus about how best to use the river while maintaining or improving its environmental qualities. The McKnight Foundation could improve this situation with a series of demonstration projects that would organize communities to think and take action towards improving the river and the communities' relationship with it. These projects would certainly affect the communities which received the funding, but the impact would be undoubtedly greater as other communities along the river watched the projects and learned from them. If the projects were chosen in a competition, new and creative approaches would be generated. And even those communities which did not receive funding would benefit from the internal communication and organization required to generate a proposal. Probably some would go ahead even without McKnight funding. Demonstration projects could be funded within a number of different types of communities: river towns, agricultural areas, wildlife and natural areas, industrial areas, and even transportation companies.

We found a wide variety of people and organizations interested in the river, but found limited common ground on which they could meet to share information and discuss joint solutions. It would be useful for the McKnight Foundation to provide a forum for the exchange of information among the various public, private, and nonprofit groups interested in the Mississippi River. Conferences, seminars, and publications ought to be used to encourage consensus-building and agenda development among the groups.

From our work in compiling this atlas we see a number of deficiencies in the way people can learn about the river. It would be useful to create an annotated index to these databases, including information about the types of information found in each, strengths and weaknesses, and a contact person. Some federal data are available only when the researcher evokes the Freedom of Information Act. In several cases, we found suspect or incomplete data, so it may be necessary to use local experts for assistance in extracting usable information. An inventory of such people would be useful. It might be possible to empower a single site to access and process all information, but we think this would not be particularly useful at this time. Inventories of key databases and individuals would be useful.

Some additional research is required to round out this study. In the beginning of this report, we listed some topics where we were unable to collect, analyze, and map data about key topics. Foremost among these topics is information about state-by-state environmental laws and regulations. Most states conduct general public opinion surveys and it would be interesting to ask a set of questions in the ten states bordering the river to compare attitudes about the environment in general and the river in particular. Other data sets that might be explored further include: plant diversity and loss of original vegetation, animal counts and diversity, dissolved oxygen in the river, industrial pollutants in the river, air quality, municipal sewer discharges, and diseases related to water. Because the potential level of purity and the nature of basic problems differs in different parts of the basin, it would be useful to place these analyses within the context of each of the various ecological regions that make up the basin of the Mississippi River.

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